Prediction and possible remedy in managing thrips (Thysanoptera: Thripidae) and MEAM1 (Hemiptera: Aleyrodidae) in tomato

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FACTS

- Tomato is grown globally in 144 countries on 3.7 million ha
- United States ranks as the top three tomato producing nations
- Florida and California are the major states in producing fresh market tomato in the nation.
- Florida generates $348 million harvesting 33,000 acres
- Production cost/acre $4.5 – 6.0 thousands
- Insecticide cost $500-700/acre

SILVERLEAF WHITEFLY- direct damage

Honey dew secretion and sooty mould

Feeding damage

50-100 eggs
5-7 days to hatch
Males are haploid
Females are diploid

SILVERLEAF WHITEFLY-indirect damage

Tomato Yellow Leaf Curl Virus :TYLCV

Silverleaf whitefly : SLW

Bean Golden Mosaic Virus : BGMV

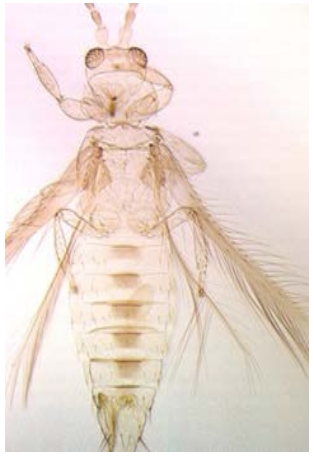
- Crop and ornamental plant
- damage: in excess of $1 billion

Thrips in tomato fields

Melon thrips

Common blossom thrips

Western flower thrips



Chilli thrips

Florida flower thrips

Onion thrips

Melon thrips damage

Melon thrips adults

Melon thrips larvae

Eggplant

Bean

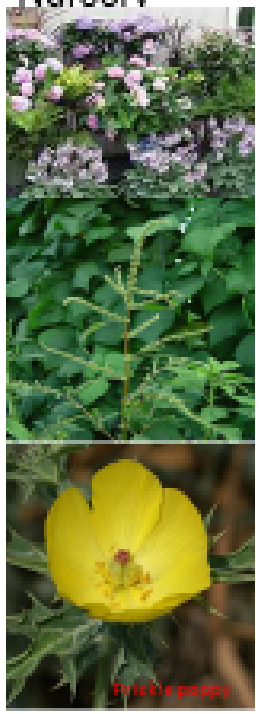
Cucumber

Squash

TCSV infected tomato field surrounded by weeds and vegetable crop

Mean number of flower thrips/100 feet long plot (6 wk after planting).

West side Nursery



Mean no. thrips

South side

East side Avocado grove

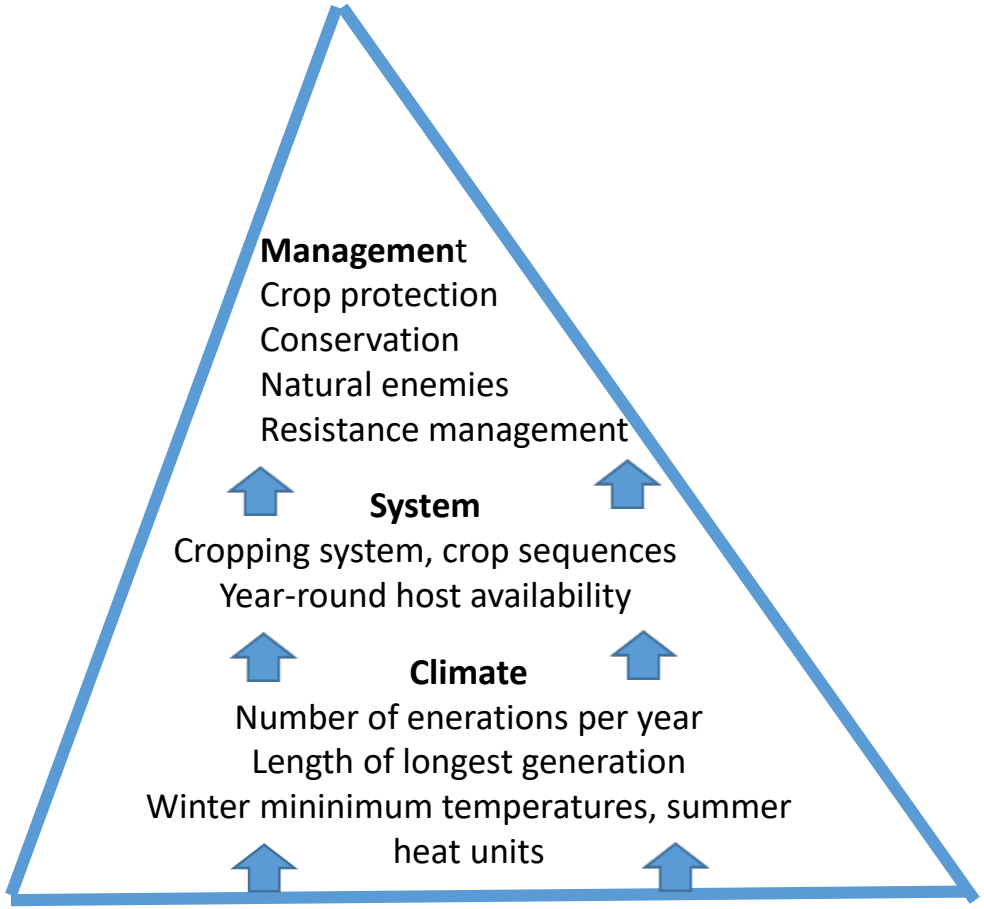
9 beds, each 800 feet long. Each bed was divided into 8 100-feet long plots. Five sub sample, each consisting of 10 randomly selected leaves, were collected from each plot.

Prediction

Accurate prediction about pest populations help in:

a. Developing appropriate cultural practices
b. Implementing management program in time
c. Providing time for biological control
d. Using less insecticide
e. Managing resistance problem
f. Saving money

Favorable situations for pest outbreak



Important factors for pest outbreak

1. The pest requires a suitable climate

2. A favorable system of suitable hosts before crop season
   Alternate host crops, ornamental plants and weeds in sequences

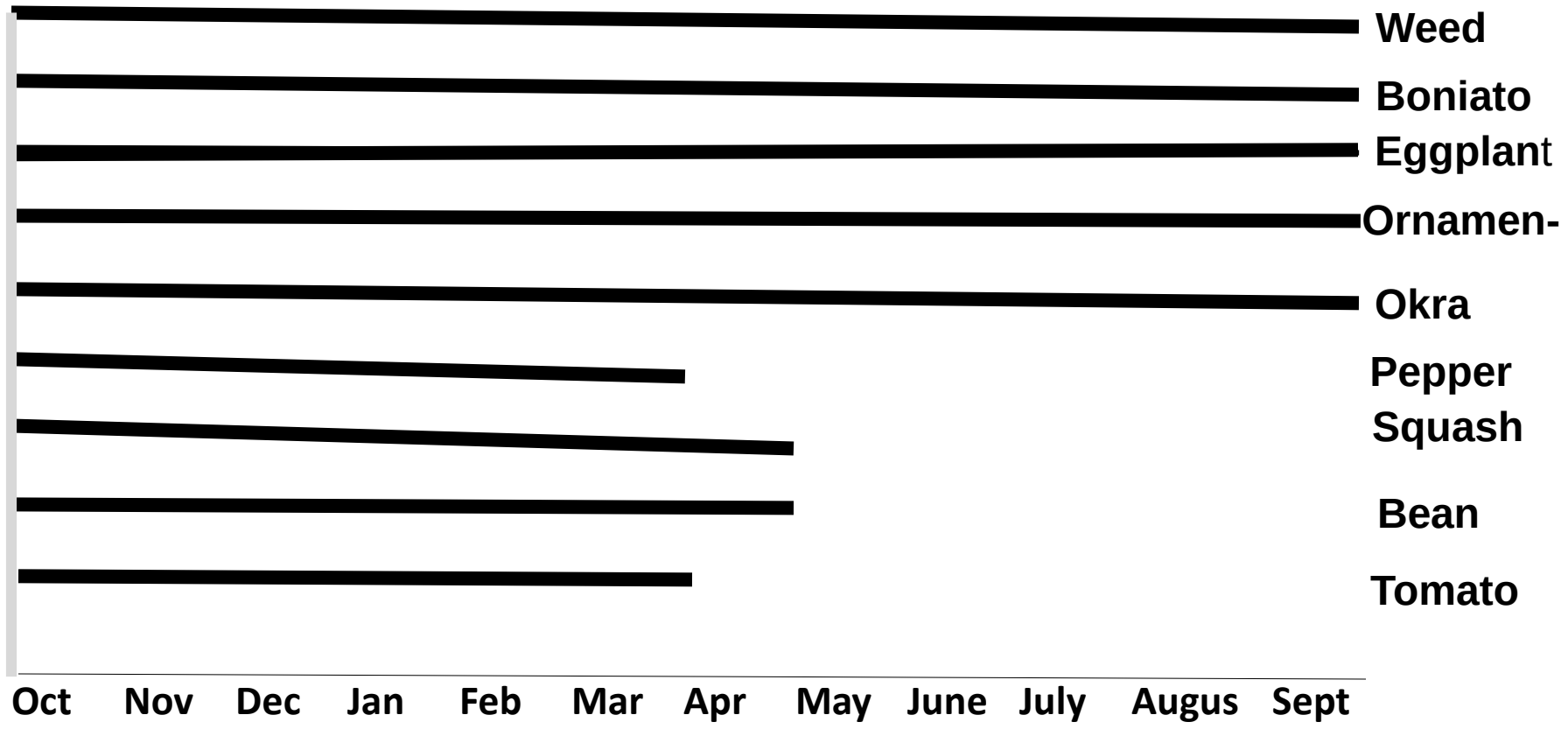
4. Use practices that disrupt natural enemies

Zelus longipes

O. insidiosus

Staphylinid

Crops growing period in Miami-Dade County



Specialty and Ethnic Vegetables

•sparagus
•Baby vegetables
•Cabbage
•Carrots
•Celery
•Chinese water chestnuts
•**Cole crops** (broccoli, cauliflower, Brussels sprouts, kohlrabi)
•Corn, miniature
•Fenugreek
•Edible flowers
•Garlic
•Gourds, ornamental
•Greenhouse production for out-of-season crops
•Heirloom varieties of any Herbs - culinary and medicinal
•Horseradish
•**ornamental**
•Luffa gourds
•Mushrooms- agaricus,
• shiitake, oyster, morel, etc.
•Onions (transplants, shallots, sweet, early)
•Organically grown vegetables of all types
•**Oriental vegetables**
•Peas and pea shoots
•**Peppers - specialty types** (purple, hot, etc.)
•**Pumpkins**
Red beets
Salad greens - mesclun
Sprouts (alfalfa, bean, etc.)
Squash
Okra
•**Eggplant (Indian and Thailand**
•**Sweet potatoes**
•**Tomatoes - specialty types**
•Truffles
•Wasabi

Crop and ornamental hosts

- 500 species of plant (USDA 1994)

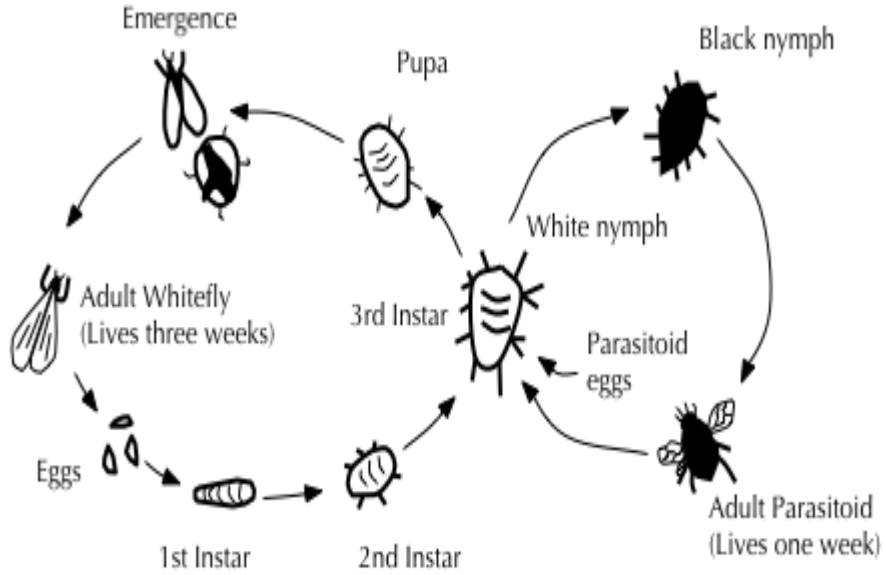
Crop hosts that support large populations include alfalfa, broccoli, cabbage, cantaloupe, cauliflower, cotton, cucumber, tomato, squash, peanut, pepper, beans, and watermelon (Perring, *et. al*., 1993b; USDA, 1994)

Ornamental hosts that support large populations include poinsettia, hibiscus, lantana, garden mum, Gerber daisies, mandevilla, and verbena (Gruenhagen, *et. al*., 1993; USDA, 1994).

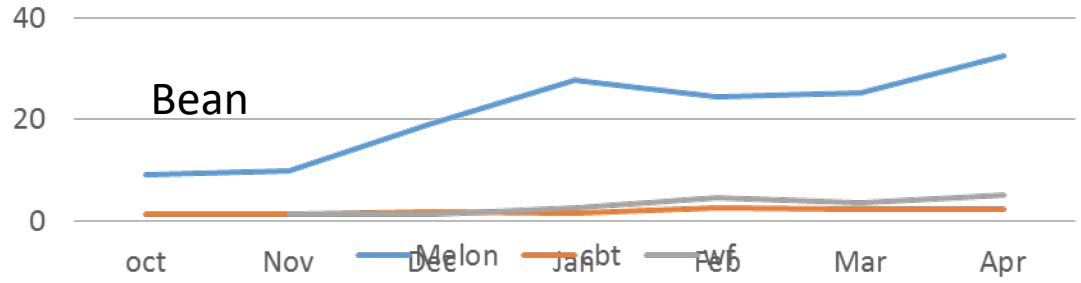
- Other preferred ornamental hosts: lilies, bearded iris, crepe myrtle, petunia, rose, and bottle brush.

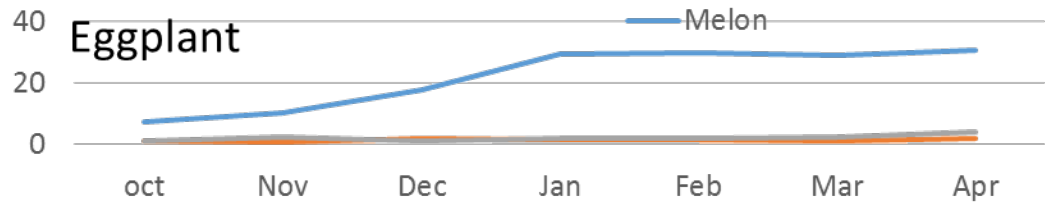
Biological control

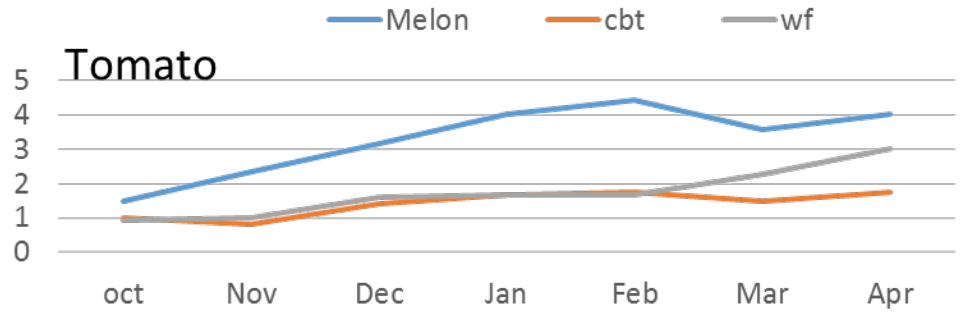
- Predators
- Parasitoids
- Pathogens
- Competitors

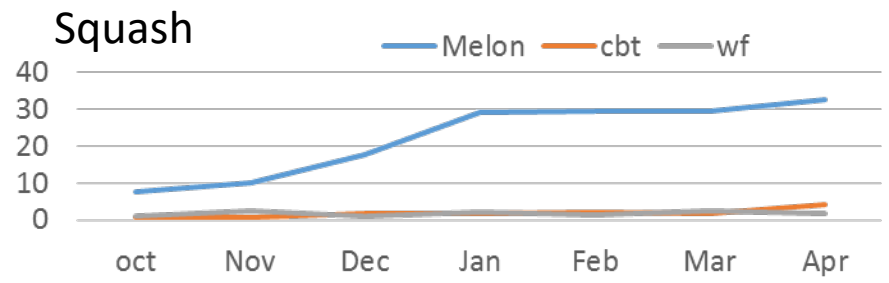


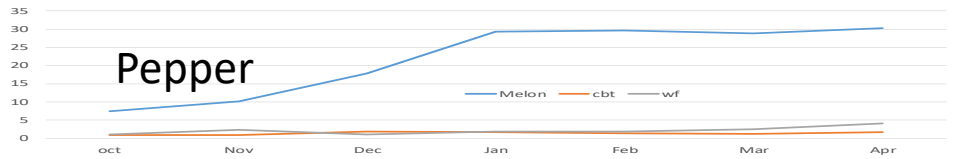
Seasonal distribution pattern of three species of thrips in five common vegetable crops (Average of 2015, 2016 and 207 data



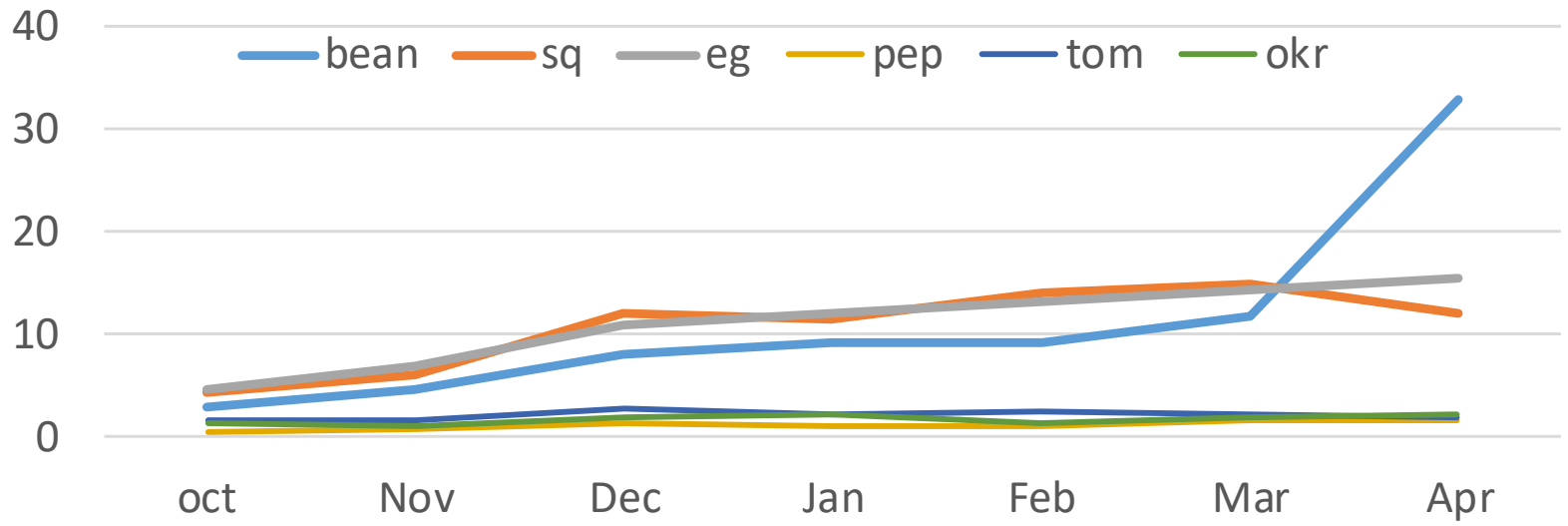




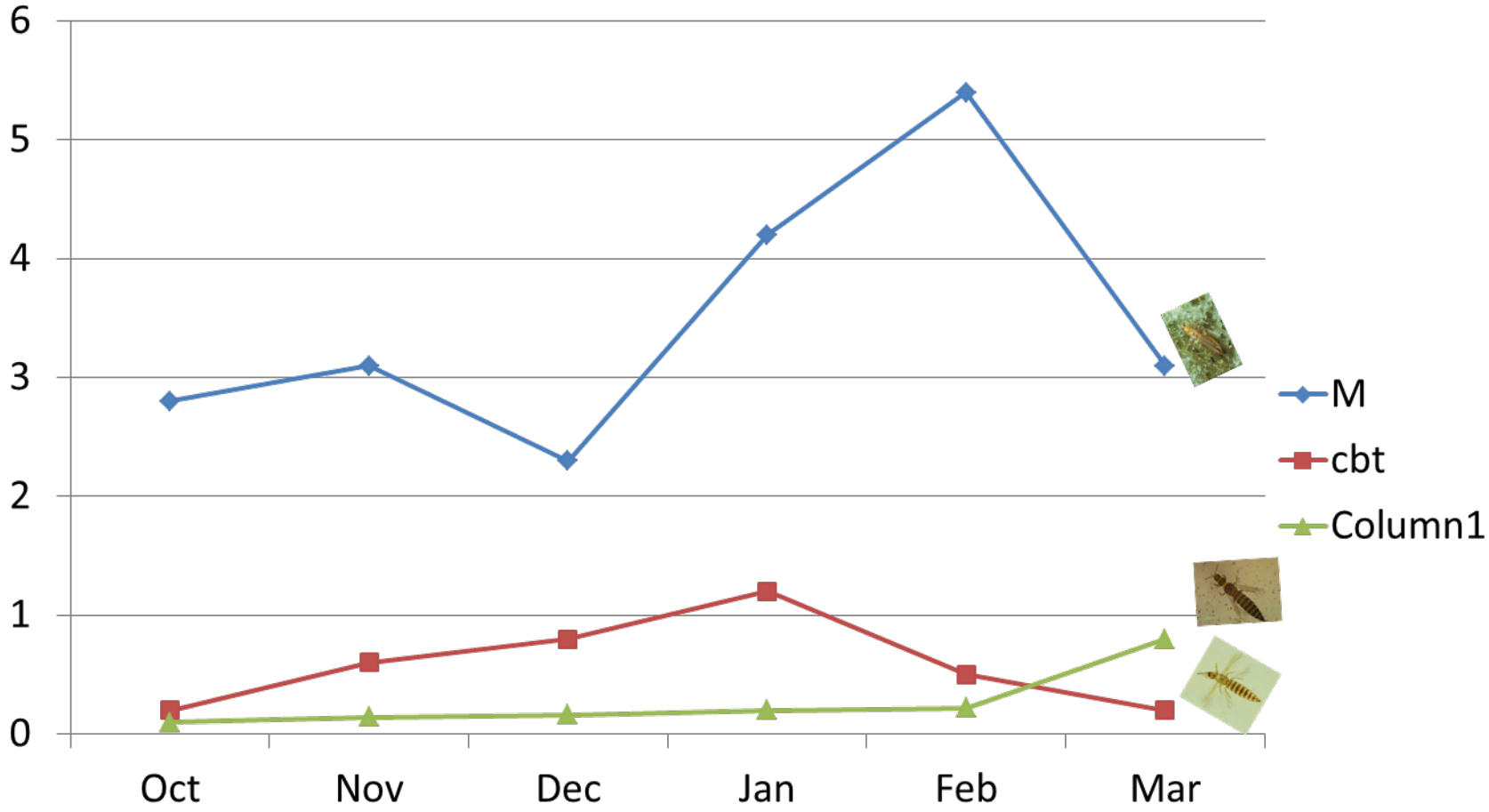




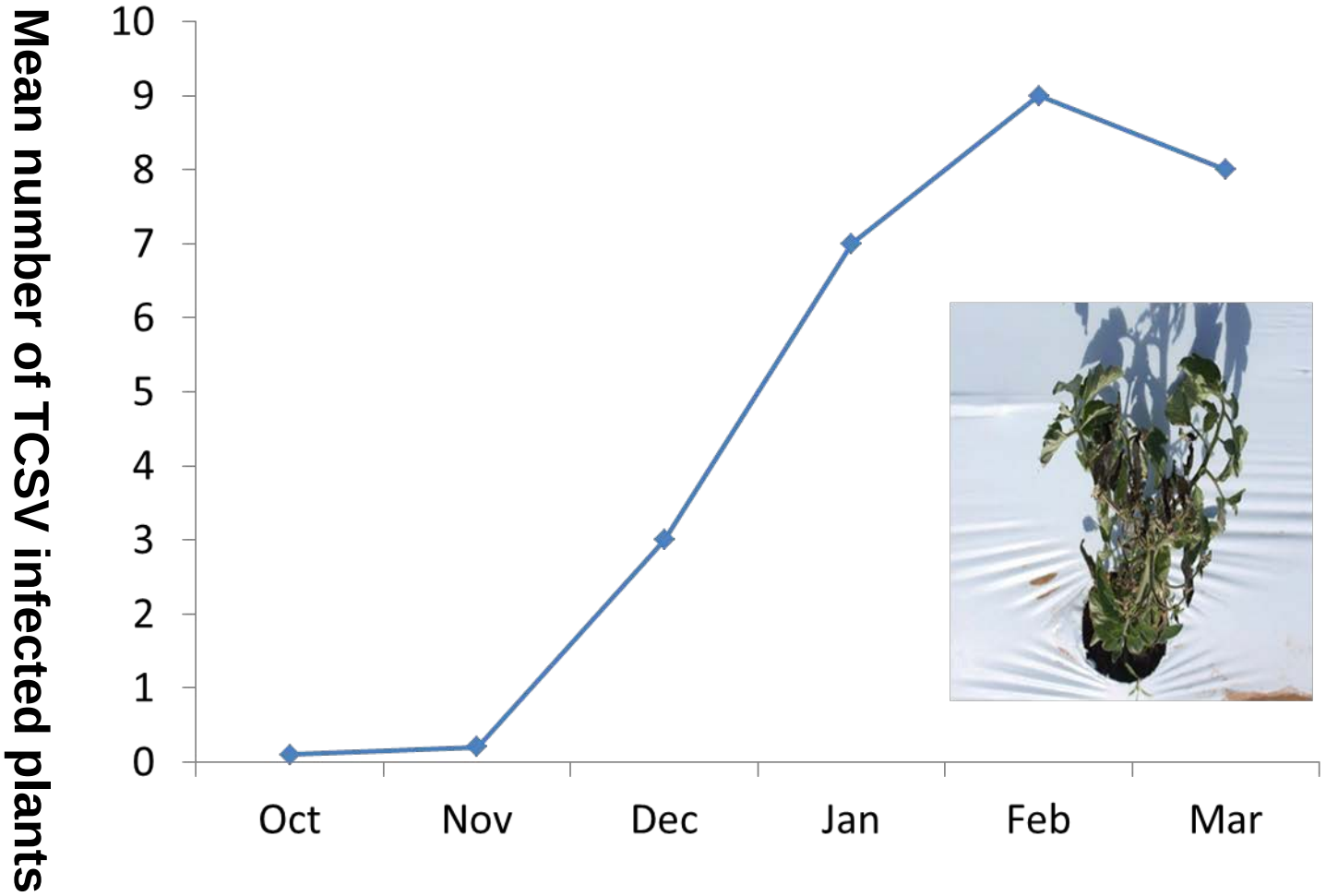
Seasonal distribution pattern of MEAM1 in five common vegetable crops (Average of 2015, 2016 and 207 data



Seasonal trend of common thrips in tomato fields



Mean numbers of TCSV infected tomato plants in different months of tomato growing season



Area-wide Action

Local Scale:

Based on suitable conditions, population multiply at one location or multiple locations

Regional scale:

Insect pests spread in all directions for new hosts

POSSIBLE REMEDY

BIOLOGICAL CONTROL

CHEMICAL CONTROL

CULTURAL CONTROL

Daily prey consumption rate of O. insidiosus by instars

Day of Instars	Instars 1st	2nd	3rd	4th	5th
1	13.1(9)	13.8(9)	14.6(5)	17.0(5)	17.7(5)
2	13.0(9)	15.4(8)	14.8(8)	12.0(7)	15.4(6)
3	20.0(5)	--	14.5(5)	19.0(5)	12.6(5)
4	--	--	--	--	15.0(5)
5	--	--	--	--	15.5(3)

CHEMICAL CONTROL

Control of thrips

1. Verimark
   Exirel
   Admire

2. Experimental
   Danitol
   Azera

3. BAM FX
   Admire
   Movento
   Radiant
   Tolfenpyrad

Control of MEAM1

Movento
Sivanto
Admire

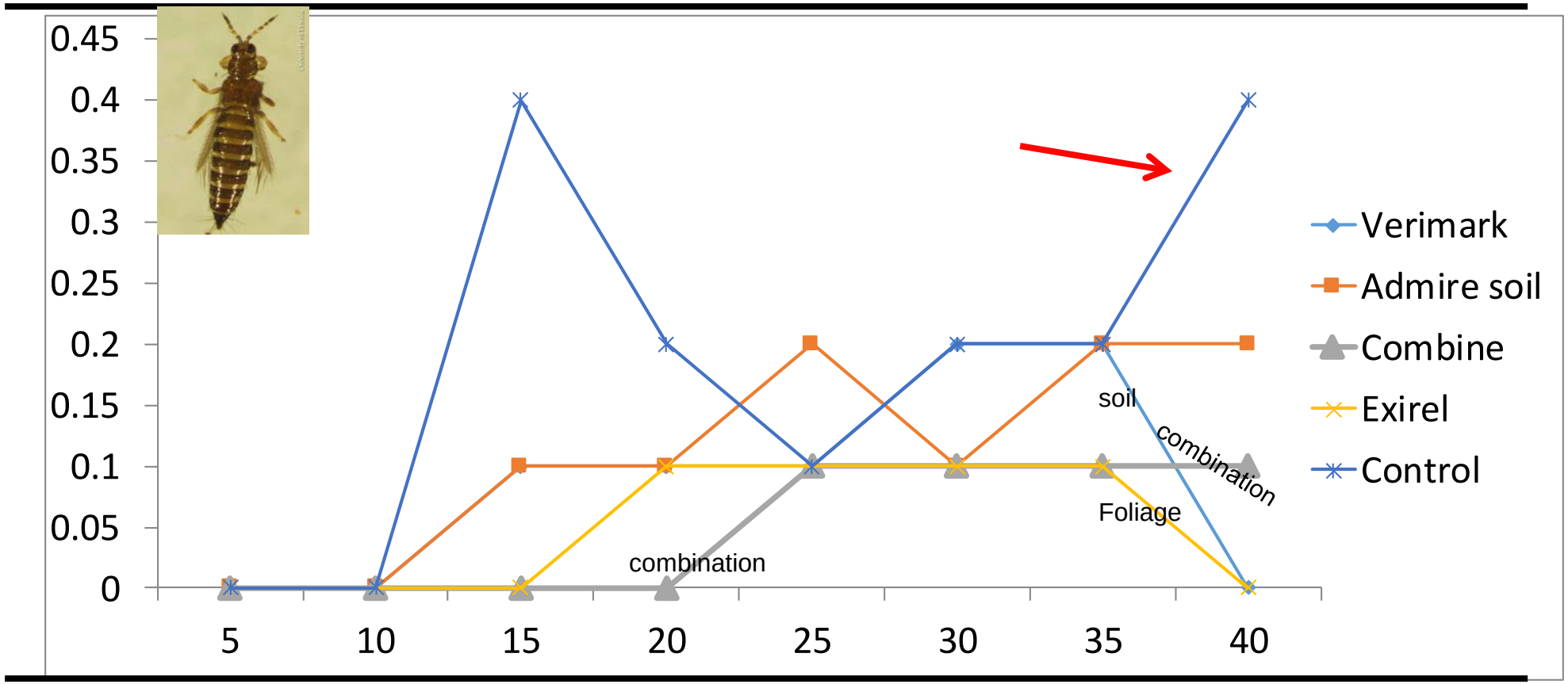
Experimental
Danitol
Azera

BAM FX
Admire
Movento
Radiant
Tolfenpyrad

Control of Flower thrips and Common blossom thrips in tomato by applying Cyantraniliprole as a soil drench

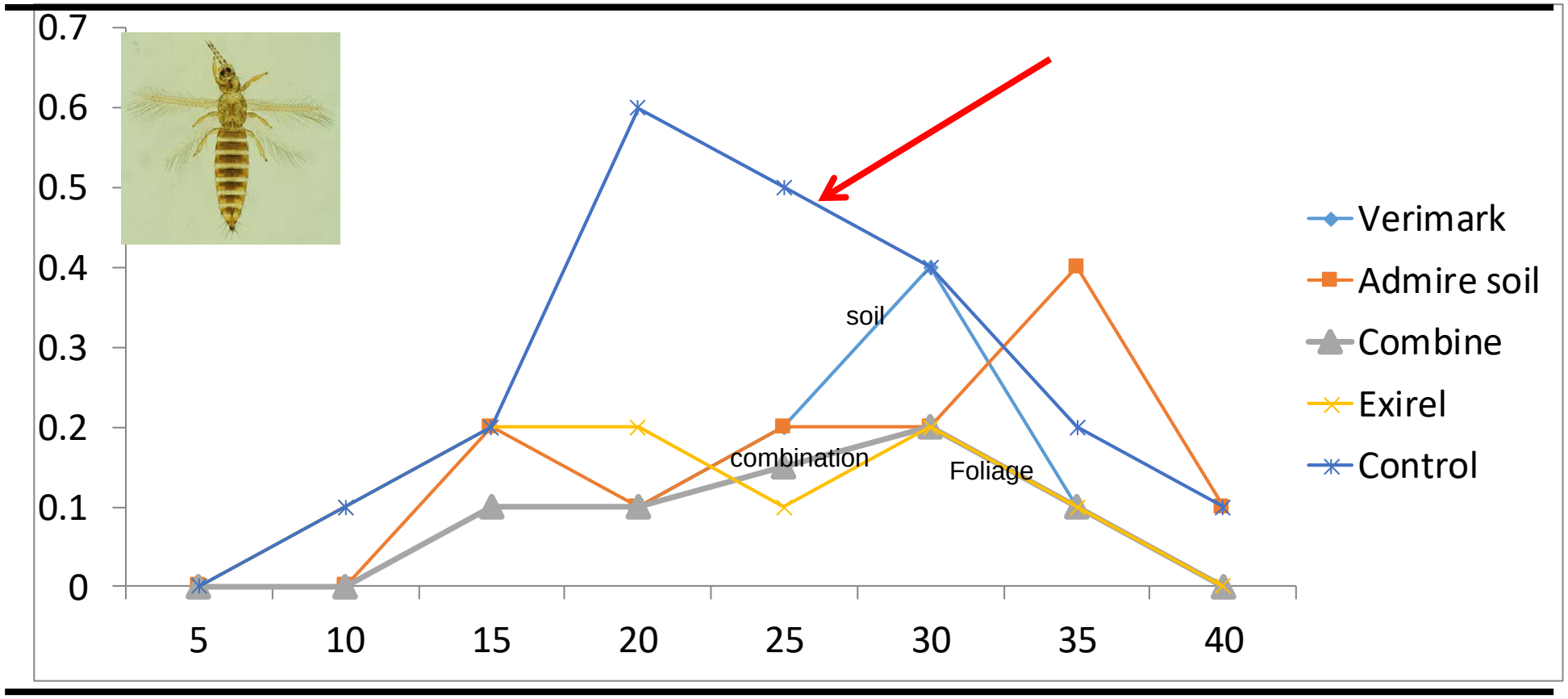
Treatments	Rate [oz]/A	Method of application	
1 Verimark 20SC	13.5	At plant	
2. Admire Pro Verimark 20SC	10.5 10.3	At plant Drip at 14 & 28 DAP	
3. Admire Pro	10.5	At plant	
4. Exirel 20SC	10.3	On foliage	
5. Untreated check			

Control of *F. schultzei* in tomatoes using DPX and Admire Pro as a soil drench



DPX applied on foliage provided better reduction of *F. schultzei* than other treatments
***F. Schultzei* was not recorded on the combination treatment for the first 20 d**

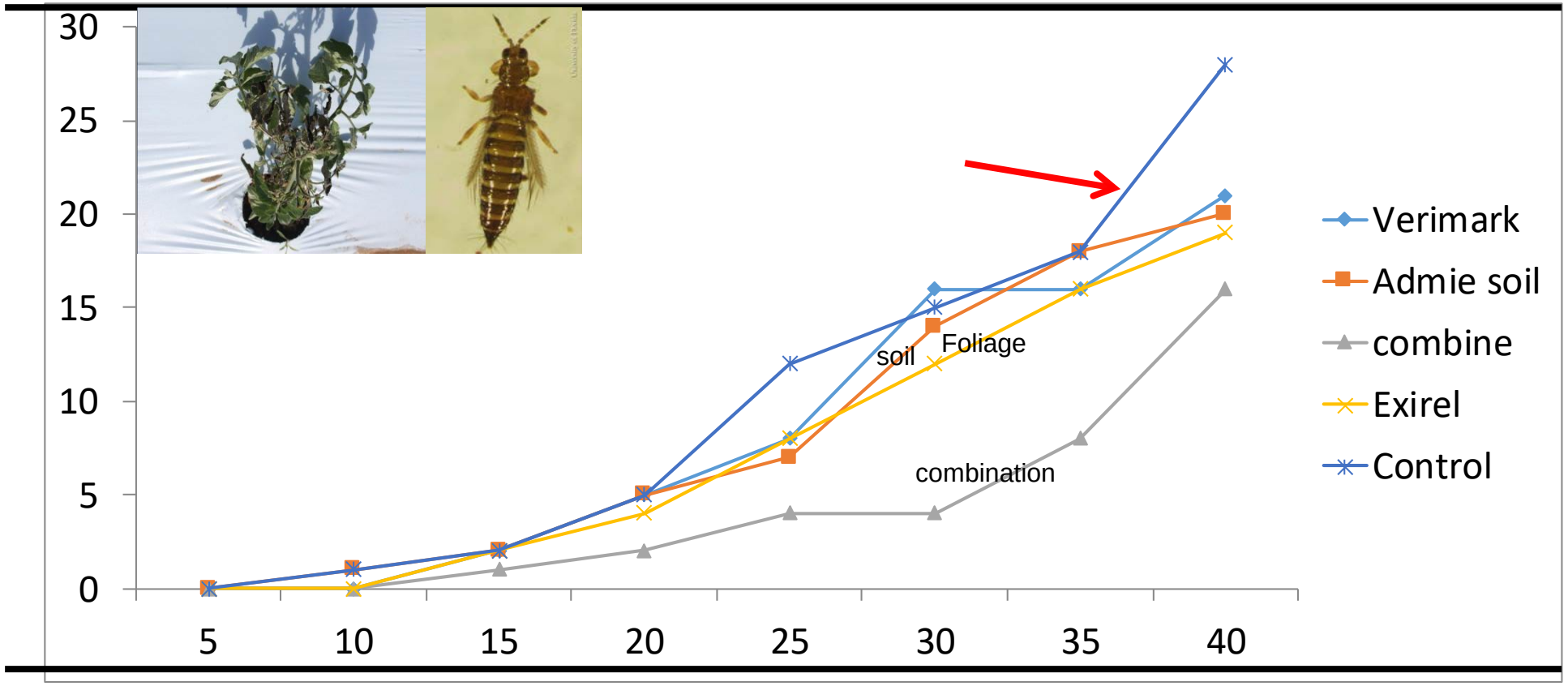
Control of *F. occidentalis* in tomatoes using DPX and Admire Pro as a soil drench



DPX applied on foliage provided better reduction of *F. occidentalis* than other treatments, but did not differ from the combination treatment

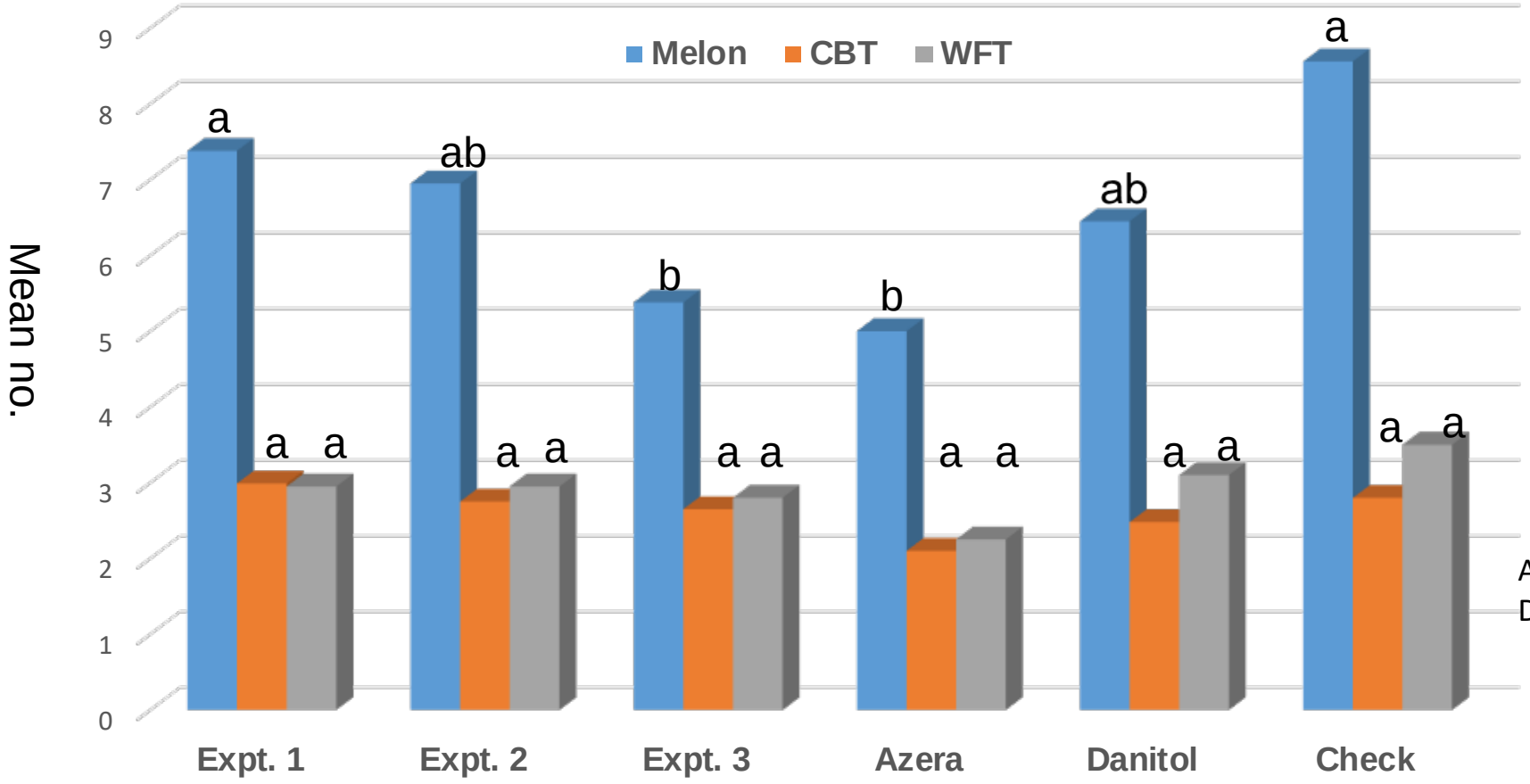
***F. occidentalis* was not recorded on the DPX treatments for the first 10 d**

Control of TCSV in tomatoes using DPX and Admire Pro as a soil drench



DPX applied on foliage did not differ from DPX applied in soil in reducing GRSV
Admire at soil followed be DPX on foliage was significantly better than all other treatments in reducing GRSV incidence.

Effectiveness of various insecticide treatments in controlling thrips on tomato



Treatments	Rate [oz]/A
Experimental	4.0
Experimental	8.0
Experimental	11.0
Azera	32.0
Danitol	16.0
Check	00

Azera: Pyrethrins; Azadirachtin
Danitol: Fenpropathrin (Gr. 3)

Expt. 3 and Azera reduced melon thrips

MANAGEMENT OF SILVERLEAF WHITEFLY

Treatments	Rate [oz]/A	Method of application	Time of Application
Movento	5.0	Foliar spray	3 and 5 WAP
Sivanto Movento	21.0 5.0	Drench Foliar spray	At plant 3 & 5 WAP
Admire Movento	10.5 5.0	Drench Foliar spray	At plant 3 & 5 WAP
Movento – Sivanto	5.0 10.5	Foliar spray Foliar spray	3 WAP 5 WAP
Control	--	--	--

Mean numbers of SLW eggs

Treatments	Rate [oz]/A	11 may	20 May	27 May
Movento	5.0	4.75b	5.05b	9.70b
Sivanto Movento	21.0 5.0	5.95b	3.35b	6.35b
Admire Movento	10.5 5.0	4.90b	3.25b	5.05b
Movento – Sivanto	5.0 10.5	1.95b	9.15b	9.65b
Control	Rate [oz]/A	301.80a	242.20a	275.55a

All treatments significa-ntly reduced eggs

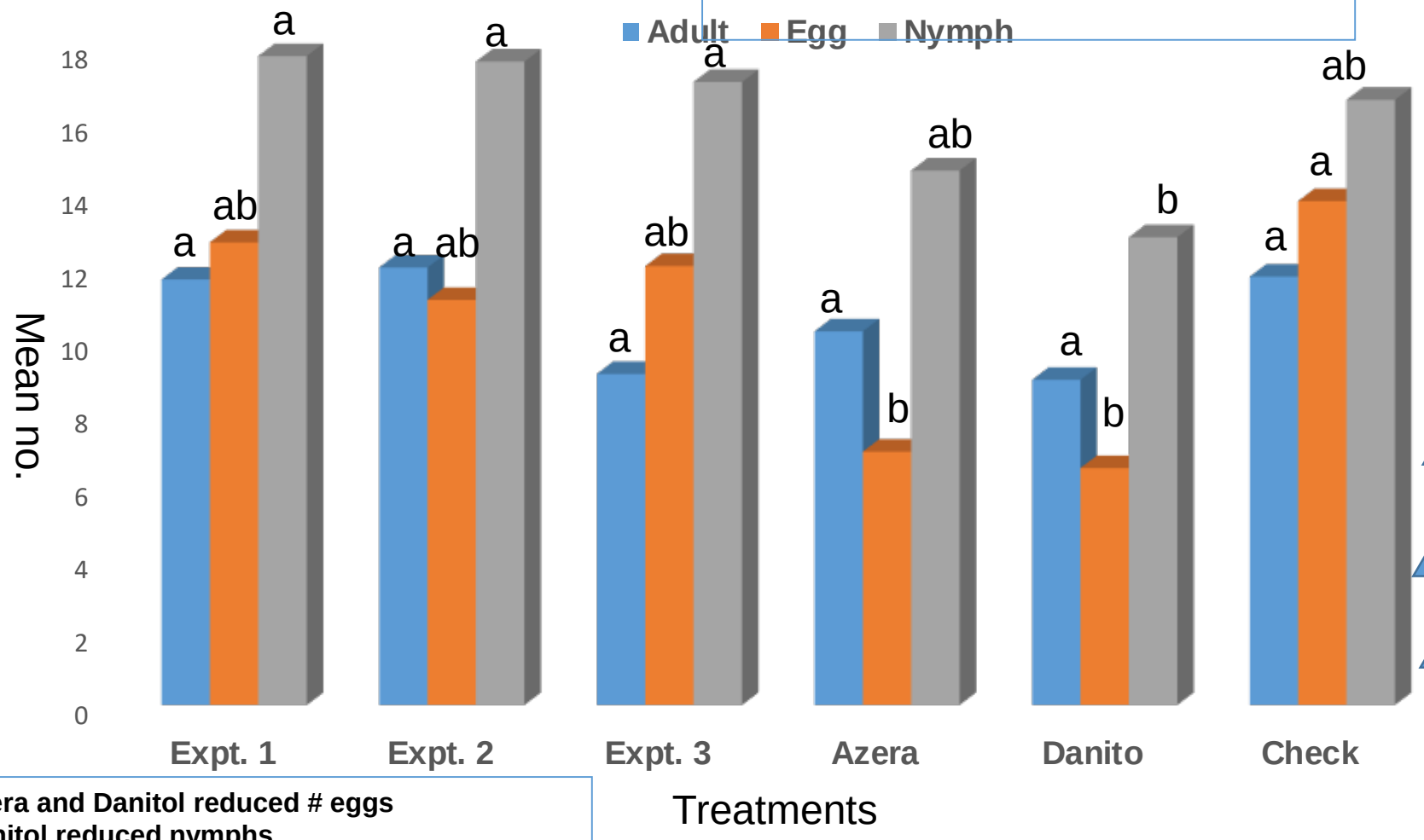
Mean numbers of SLW nymphs

Treatments	Rate [oz]/A	11 May	20 May	27 May
Movento	5.0	0.05b	0.30b	0.40b
Sivanto Movento	21.0 5.0	0.75b	0.45b	0.25b
Admire Movento	10.5 5.0	0.55b	0.45b	28.58b
Movento – Sivanto	5.0 10.5	0.10b	1.45b	0.45b
Control		77.60a	83.25a	43.65a

All treatments significantly reduced nymphs

Effectiveness of various insecticide treatments in controlling silverleaf whitefly on tomato

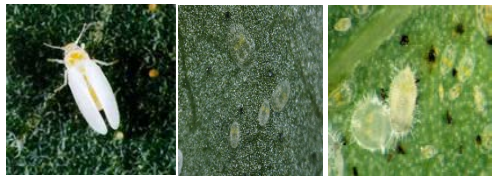
Azera and Danitol reduced # eggs
Danitol reduced nymphs



Treatments	Rate [oz]/A
Experimental	4.0
Experimental	8.0
Experimental	11.0
Azera	32.0
Danitol	16.0
Check	00

Azera: Pyrethrins; Azadirachtin
Danitol: Fenpropathrin (Gr. 3)

- **Insecticide treatments did not reduce adults**
- **Azera and Danitol reduced # SLW eggs**
- **Danitol reduced # SLW nymphs**



Azera and Danitol reduced # eggs
Danitol reduced nymphs

Mean number of melon thrips/five leaf sample of tomato treated with BAM-FX

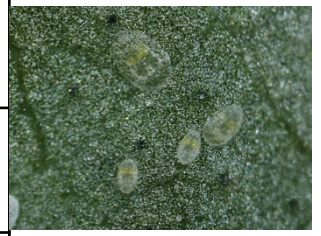
Treatment No.	BAM-Ins-NPK*			14 Dec	14 Dec	28 Dec	04 Jan	11 Jan	18 Jan
1	Fol	0	0	0.19a	0.44ab	0.25bc	0.69c	0.67b	0.90bc
2	Soil	0	0	0.31a	0.44ab	0.63ab	1.06bc	0.17c	1.00b
3	Fol	Ins	0	0.13a	0.00c	0.31bc	0.56c	0.09c	0.50cd
4	Soil	Ins	0	0.25a	0.18bc	0.13c	0.56c	0.08c	0.40d
5	0	Ins	NPK	0.50a	0.56ab	0.81a	1.63ab	1.00b	1.30b
6	0	0	NPK	0.50a	0.75a	1.19a	1.94a	2.33a	2.75a

Means within a column followed by a same letter do not differ significantly (P > 0.05; Waller-Duncan K-ratio t Test.

Mean number of SLW adults/five leaf sample of tomato treated with BAM-FX

Treatments	BAM-Ins-NPK*			14 Dec	21 Dec	28 Dec	04 Jan	11 Jan	18 Jan
1	Fol	0	0[1]	0.17c	0.25b	0.67bc	0.50c	0.67b	0.90bc
2	Soil	0	0	0.17c	0.17b	0.50c	0.58c	0.17c	1.00b
3	Fol	Ins	0	0c	0.25b	0.25c	0.33c	0.09c	0.50cd
4	Soil	Ins	0	0.25c	0.50b	0.33c	0.42c	0.08c	0.40d
5	0	Ins	NPK	0.91b	1.92a	1.17b	1.17b	1.00b	1.30b
6	0	0	NPK	1.42a	2.42a	2.17a	2.16a	2.33a	2.75a

Mean number of SLW eggs/leaf sample of tomato treated with BAM-FX



Treatments	BAM-Ins-NPK*			14 Dec	21 Dec	28 Dec	04 Jan	11 Jan	18 Jan
1	Fol	0	0	0.08b	1.00b	2.08c	2.08c	2.08c	2.05bc
2	Soil	0	0	0.25b	0.83b	1.58cd	1.58cd	1.25d	2.65b
3	Fol	Ins	0	0.17b	0.50b	0.92e	0.92e	1.00de	0.40d
4	Soil	Ins	0	0.17b	0.58b	1.00de	1.00de	0.58e	0.55d
5	0	Ins	NPK	1.00a	1.92b	3.50b	3.50b	3.92b	1.80c
6	0	0	NPK	1.42a	2.83a	4.67a	4.67a	6.33a	3.95a

Mean number SLW nymphs/leaf sample of tomato treated with BAM-FX

Treatment	BAM-Ins-NPK*			14 Dec	21 Dec	28 Dec	04 Jan	11 Jan	18 Jan
1	Fol	0	0	0.25b	0.58b	0.42c	0.42c	0.83b	0.65b
2	Soil	0	0	0.08b	0.25b	0.33c	0.33c	0.42b	0.75b
3	Fol	Ins	0	0.17b	0.25b	0.33c	0.33c	10.27ab	0.00c
4	Soil	Ins	0	0.08b	0.25b	0.08c	0.08c	0.0b	0.10c
5	0	Ins	NPK	1.08a	2.00a	1.83b	1.83b	2.17ab	0.85b
6	0	0	NPK	1.33a	2.08a	3.00a	3.00a	4.50a	2.65a

Mean number of TYLCV/plot of tomato treated with various treatments

Treatments	BAM-Ins-NPK*			14 Dec	21 Dec	28 Dec	04 Jan	11 Jan	18 Jan
1	Fol	0	0	0.26b	1.00a	1.75bc	3.25bc	2.50bc	1.75
2	Soil	0	0	0.25b	1.25a	1.75bc	3.00bc	2.75bc	2.00
3	Fol	Ins	0	0b	1.00a	1.00c	1.50d	2.25c	1.25
4	Soil	Ins	0	0b	0.75a	1.50c	2.25cd	2.25c	0.75
5	0	Ins	NPK	0.75b	1.00a	2.75ab	4.00b	4.50a	3.00
6	0	0	NPK	1.75a	1.25a	4.00a	6.00a	3.25ab	4.00

Mean number of TCSV/plot of tomato treated with various treatments

Treatments	BAM-Ins-NPK			14 Dec	21 Dec	28 Dec	04 Jan	11 Jan	18 Jan
1	Fol	0	0	0.25ab	0.50a	1.00ab	2.25ab	3.00a	1.40
2	Soil	0	0	0b	0.50a	0.75b	1.75b	2.00ab	1.48
3	Fol	ins	0	0b	0.50a	1.50ab	2.00b	2.25ab	1.21
4	Soil	ins	0	0b	0.50a	1.25ab	1.75b	2.00ab	0.90
5	0	Ins	NPK	0.50ab	0.50a	2.25a	2.50ab	2.25ab	1.79
6	0	0	NPK	1.00a	1.25a	2.25a	3.50a	1.50b	2.05

Number of fruits/tomato plant treated with various treatments

Treatments	BAM-Ins-NPK			2014	2016
1	Fol	0	0	3.20bc	4.95c
2	Soil	0	0	2.30c	3.50d
3	Fol	ins	0	3.40bc	6.10b
4	Soil	ins	0	4.25b	5.40bc
5	0	Ins	NPK	12.60a	13.85a
6	0	0	NPK	11.75a	12.85a

CULTURAL CONTROL

Table 1.

Number of various thrips species on different ornamental plants grown inside commercial greenhouses

Name of ornamental plants	Common name of ornamental plants	No. of thrips found			
		WFT	CBT	MT	Larva
Torenia sp.	wishbone flowers	15	0	9	10
Hibiscus sp.	China rose	90	0	33	117
Fuchsia sp.	Fuchsia	14	0	9	4
Ericameria arborescens	Golden Fleece	0	2	0	5
Petinia sp.	Petunia	8	0	5	3
Cosmos sp.	Cosmos	23	0	6	6
Tagetes sp.	Marygold	11	0	0	13
Pentas lanceolata	Egyptian starcluster	0	0	3	0
Gerbera sp.	Garbers Daisy	5	0	4	17
Portulaca oleracea	Purselane	42	2	2	44
Gazania linearis	Treasure flower	70	2	23	10
Lantana camara	lantanas	3	0	3	10
Impatiens walleriana	Busy lizzy	5	2	0	13

Name of ornamental plants	Common name of ornamental plants	No. of thrips found			
		WFT	CBT	MT	Larva
Begonia semperflorens	Begonia	5	0	3	0
Kalanchoe blossfeldiana	Kalanchoe	8	0	0	3
Lilium matrix	Lilium	39	0	5	5
Helianthus annuus	Sunflower	18	0	0	12
Catharanthus roseus	rose periwinkle	0	0	0	2
Canna spp.	Cannatropical	13	0	0	14
Celosia argentea	plumed cockscomb	22	0	5	8
Plumbago auriculata	Blue plumbago,	28	7	2	13
Agastache sp.	Arozona Sandstone	49	2	0	351
Mandevilla sp.	Rocktrumpet.	15	5	0	30

Number of various thrips species on different weed host near a tomato field

Name of the weed species	Common name of weed	No. of thrips found			
		WFT	CBT	MT	Larva
Chenopodium album	pigweed	0	2	23	7
Euphorbia heterophylla	wild poinsettia/	0	0	2	3
Ipomea hederopholia	Scarlet morning glory	0	0	0	0
Parthenium hysterophorus	Santa-Maria	0	3	0	5
Bidens alba	Spanish needles	0	2	289	182
Phylla nodiflora	frog fruit/sawtooth fogfruit	0	0	0	0
Euphorbia hirta	Milkweed	0	2	10	28
Chamaesyce hyssopifolia	Hyssopleaf sandmat	0	0	12	17
Amaranthus polygonoides	Tropical amaranth/	0	1	66	28
Amaranthus spinosus	Spiny amaranth	0	0	35	43
Acalypha alepecurodea	Foxtail copperleaf	0	0	0	0

Name of the weed species	Common name of weed	No. of thrips found			
		WT	CBT	MT	Larva
Lantana camara	wild-sage/red-sage	0	0	5	5
Macroptilium lathyroides	Phasey bean/wild bushbean	0	1	0	0
Portulaca oleracea	Purslane	0	11	4	26
Sida ulmifolia	Common wireweed	0	0	0	0
Sida spinosa	Prickly fanpetals	0	0	0	0
Jasminum fluminense	Brazilian jasmine	0	20	3	5
Phyllanthus amarus	Bahupatra (Sanskrit)	0	0	0	8
Stylosanthes hamata	Cheesytoes	0	1	12	38
Spermacoce verticillata	Shrubby false buttonweed	0	2	0	4
Morinda royoc	cheese shrub	0	0	0	0

Conclusion

- Accurate prediction about pests outbreak is essential for developing successful management program.
- Prediction should be based on area-wide basis
- Admire in combination with Verimar and Exirel provide suppression of F. schultzei and TCSV incidence in tomato
- Azera effective in suppressing thrips and silverleaf whitefly populations and should be considered as a partner in rotation program for controlling these pests
- Sivanto and Movento in rotation is effective treatments for controlling whitefly population.
- Further studies should be continued to determine BAM FX fit in vegetable pest management.

Thanks!

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